

CLAIMS

What is claimed is:

- 1 1. An apparatus comprising:
2 a network element to be coupled to a first and second span of a plurality of
3 spans that interconnect a set of network elements to form a ring network,
4 each of said plurality of spans having two sub-spans on which traffic
5 travels in opposite directions on a plurality of channels that circumvent
6 said ring, each said plurality of channels including working channels and
7 protecting channels, said network element including,
8 a traffic handler to reprogram, responsive to protection switches and un-
9 switches, the connection configuration on the protecting channels
10 of the sub-spans of the first and second spans that provide traffic
11 to the network element.
- 1 2. The apparatus of claim 1, wherein, responsive to a protection switch, two
2 different connection configurations are programmed on the protecting channels of the
3 sub-spans of the first and second spans that provide traffic to the network element.
- 1 3. The apparatus of claim 1, wherein, responsive to a protection switch, the same
2 connection configuration is programmed on the protecting channels of the sub-spans of
3 the first and second spans that provide traffic to the network element.
- 1 4. The apparatus of claim 1, wherein, responsive to a protection un-switch, two
2 different connection configurations are programmed on the protecting channels of the
3 sub-spans of the first and second spans that provide traffic to the network element.
- 1 5. The apparatus of claim 1, wherein, responsive to a protection un-switch, the
2 same connection configuration is programmed on the protecting channels of the sub-
3 spans of the first and second spans that provide traffic to the network element.
- 1 6. The apparatus of claim 1, wherein said traffic handler includes a connection
2 table generator to communication connection configuration information with others of
3 said plurality of network elements.

1 7. The apparatus of claim 1, wherein said ring network is a modified bi-direction
2 line switched ring.

1 8. The apparatus of claim 1, wherein said network element further includes:
2 a first set of structures to store the connection configurations programmed on
3 the working and protecting channels of the sub-spans of the first and
4 second spans that provide traffic to the network element; and
5 a second set of structures to store the connection configurations programmed on
6 the working channels of those of said plurality of spans not directly
7 connected to the network element.

1 9. An apparatus comprising:
2 a network element coupled to a first and second span of a plurality of spans that
3 interconnect a set of network elements to form a ring network, each of
4 said plurality of spans having two sub-spans on which traffic travels in
5 opposite directions on a plurality of channels that circumvent said ring,
6 each said plurality of channels including working channels and
7 protecting channels, said network element including a machine readable
8 medium having stored thereon instructions, which when executed by a
9 set of one or more processors, cause said set of processors to perform
10 operations including,
11 storing in a first set of structures connection configurations for the
12 working and protecting channels programmed on the receiving
13 side of the ports coupled to the sub-spans of the first and second
14 spans; and
15 storing in a second set of structures the connection configurations
16 programmed on the working channels of those of said plurality
17 of spans not directly connected to said node.

1 10. The apparatus of claim 9, wherein said storing in said first set of structures
2 includes storing one connection configuration for both of the working and protecting
3 channels on the receiving side of both of the ports coupled to of the sub-spans of the
4 first and second spans.

- 1 11. The apparatus of claim 9, wherein said storing in said first set of structures
2 includes storing one connection configuration for each of the working and protecting
3 channels on the receiving side of both of the ports coupled to of the sub-spans of the
4 first and second spans.
- 1 12. The apparatus of claim 9, wherein said storing in said first set of structures
2 includes storing one connection configuration for both of the working and protecting
3 channels on the receiving side of each of the ports coupled to of the sub-spans of the
4 first and second spans.
- 1 13. The apparatus of claim 9, wherein said storing in said first set of structures
2 includes storing one connection configuration for each of the working and protecting
3 channels on the receiving side of each of the ports coupled to of the sub-spans of the
4 first and second spans.
- 1 14. The apparatus of claim 9, wherein said ring network is a modified bi-direction
2 line switched ring.
- 1 15. The apparatus of claim 9, wherein said machine readable medium further
2 includes:
3 a traffic handler, to be coupled to said first and second set of structures, to
4 reprogram, responsive to protection switches and un-switches, the
5 connection configurations for the protecting channels programmed on
6 the receiving side of the ports coupled to of the sub-spans of the first and
7 second spans.
- 1 16. The apparatus of claim 9, wherein said machine readable medium further
2 includes:
3 a traffic handler, to be coupled to said first set of structures, to reprogram,
4 responsive to protection un-switches, the connection configurations for
5 the protecting channels on the receiving side of the ports coupled to of
6 the sub-spans of the first and second spans; and
7 said traffic, to be coupled to said second set of structures, to reprogram,
8 responsive to protection switches, the connection configurations for the

9 protecting channels on the receiving side of the ports coupled to of the
10 sub-spans of the first and second spans.

1 17. An apparatus comprising:
2 a network element to be coupled to a first and second span of a BLSR ring, said
3 network element including,
4 means for providing different connection configurations on the
5 protecting channels of said first and second spans responsive to
6 protection switches and un-switches.

1 18. The apparatus of claim 17, where said means allows a first of said plurality of
2 channels to be part of two different sized connections programmed on said first and
3 second spans.

1 19. The apparatus of claim 17, where said means allows said first spans to have
2 programmed thereon a concatenation of a plurality of the BLSR channels that is not
3 programmed on said second span.

1 20. The apparatus of claim 17, wherein said means includes:
2 a storage means for storing said different connection configurations; and
3 a hardware control means for programming ports of said network element
4 coupled to said first and second spans.

1 21. An apparatus comprising:
2 a plurality of network elements;
3 a plurality of spans interconnecting said plurality of network elements to form a
4 ring, each of said plurality of spans having two sub-spans on which
5 traffic travels in opposite directions;
6 a multiplexing ring transport network protocol operating on said ring providing
7 a plurality of channels on each of said sub-spans, each of said plurality
8 of channels includes a set of working channels and a mutually exclusive
9 set of protecting channels, wherein a first connection configuration
10 programmed on a first of said sets of channels is not the same as a
11 second connection configuration programmed on a second of said sets of
12 channels.

1 22. The apparatus of claim 21, wherein said first set of channels and said second set
2 of channels are respectively the set of working channels and the set of protecting
3 channels on a same one of said sub-spans.

1 23. The apparatus of claim 22, wherein the same connection configuration must be
2 programmed on each of said sets of working channels.

1 24. The apparatus of claim 22, wherein the same connection configuration must be
2 programmed on each of said sets of working channels on which traffic travels in the
3 same direction as said first set of channels, and wherein a third connection
4 configuration is programmed on each of said sets of working channels on which traffic
5 travels in the opposite direction as first set of channels, and wherein said first and third
6 connection configurations differ.

1 25. The apparatus of claim 22, wherein the same connection configurations must be
2 programmed on the set of working channels of both sub-spans of any given one of said
3 spans, and wherein the connection configurations programmed on the sets of working
4 channels of two different ones of said spans differ.

1 26. The apparatus of claim 22, wherein the connection configurations programmed
2 on the sets of working channels of two different ones of said spans differ, and wherein
3 the connection configurations programmed on the set of working channels of each of
4 the sub-spans of at least one of said spans differ.

1 27. The apparatus of claim 21, wherein said first set of channels and said second set
2 of channels are the sets of working channels on two different ones of said sub-spans.

1 28. The apparatus of claim 27, wherein said two different ones of said sub-spans are
2 part of a same one of said spans.

1 29. The apparatus of claim 27, wherein said two different ones of said sub-spans are
2 part of two different ones of said spans.

1 30. The apparatus of claim 27, wherein the same connection configuration must be
2 programmed on each of said sets of working channels on which traffic travels in the
3 same direction as said first set of channels.

1 31. The apparatus of claim 27, wherein the same connection configuration must be
2 programmed on the set of working channels of both sub-spans of any given one of said
3 spans.

1 32. The apparatus of claim 27, wherein said two different ones of said sub-spans are
2 part of a same one of said spans, and wherein a third connection configuration is
3 programmed on the set of working channels of a sub-span of a different one of said
4 spans, and wherein said third connection configuration is not the same as said first
5 connection configuration.

1 33. The apparatus of claim 21, wherein said multiplexing ring transport protocol is
2 a bi-directional line switched ring protocol.

1 34. An apparatus comprising:
2 a plurality of network elements;
3 a plurality of spans interconnecting said plurality of network elements to form a
4 ring, each of said plurality of spans including two sub-spans, said sub-
5 spans forming two sub-rings, wherein a plurality of channels circumvent
6 said ring on each of said sub-rings, each of said plurality of channels
7 including working channels and protecting channels; and
8 a traffic handler on each of said plurality of network elements that together
9 reprogram the connection configurations of the protecting channels on at
10 least certain of said sub-spans responsive to protection switches and un-
11 switches.

1 35. The apparatus of claim 34, wherein said traffic handlers provide for different
2 connection configurations on a per sub-span basis without mirroring.

1 36. The apparatus of claim 34, wherein said traffic handlers provide for different
2 connection configurations on a per sub-span basis with mirroring.

1 37. The apparatus of claim 34, wherein said traffic handlers provide for different
2 connection configurations on a per span basis with mirroring.

1 38. The apparatus of claim 34, wherein said traffic handlers provide for different
2 connection configurations on a per span basis without mirroring.

1 39. The apparatus of claim 34, wherein said traffic handlers provide for different
2 connection configurations on a per sub-ring basis with mirroring.

1 40. The apparatus of claim 34, wherein said traffic handlers provide for different
2 connection configurations on a per sub-ring basis without mirroring.

1 41. The apparatus of claim 34, wherein the same connection configuration must be
2 provided on the working channels of every sub-span, but said traffic handlers provide
3 for a different connection configuration on the protecting channels.

1 42. The apparatus of claim 34, wherein each of said plurality of network elements
2 includes:
3 a first set of structures having stored therein the connection configurations
4 programmed on the working and protecting channels of the sub-spans
5 that provide traffic to the network element; and
6 a second set of structures having stored therein the connection configurations
7 programmed on the working channels of those of said plurality of spans
8 not directly connected to the network element.

1 43. The apparatus of claim 34, wherein said ring is operated as a bi-directional line
2 switched ring.

1 44. The apparatus of claim 34, wherein each of said network elements participates
2 as a node of said ring, each node having stored therein the connection configuration
3 programmed on the working channels of at least every one of said plurality of spans not
4 directly connected to that node.

1 45. The apparatus of claim 34, wherein each of said traffic handlers includes a
2 connection table generator to communication connection configuration information.

1 46. A method comprising:
2 responsive to a failure in a span in a ring network, indicating a protection switch
3 to occur on said ring network, wherein said ring network operates on a
4 plurality of network elements that participate as nodes of said ring
5 network and that are connected by spans to form a ring, each of said
6 plurality of spans including two sub-spans on which traffic travels in
7 opposite directions on a plurality of channels, each of said sub-spans
8 coupled to a receiving side and a transmitting side of ports on two
9 different ones of said nodes, said plurality of channels in each direction
10 including a set of working channels and a set of protecting channels; and
11 responsive to said protection switch, programming the receiving side of those of
12 said ports that are coupled to operable sub-spans so that their protection
13 channels have programmed thereon the connection configuration of the
14 working channels programmed on the opposite direction sub-spans of
15 said failed span.

1 47. The method of claim 46, where said programming includes:
2 each of said node, selecting from a storage of the connection configurations of
3 the working channels of each of said spans the connection configuration
4 of the working channels programmed on said failed span.

1 48. The method of claim 46, further comprising:
2 storing, prior to said indicating, in each of said plurality of networks
3 information identifying the connection configurations of the working
4 channels of each of the spans not directly connected to that network
5 element.

- 1 49. The method of claim 48, further comprising:
2 communicating, prior to said storing, between said plurality of network
3 elements said information.
- 1 50. The method of claim 46, further comprising:
2 responsive to a correction of said failure, indicating a protection un-switch; and
3 responsive to said protection un-switch, reprogramming the receiving side of
4 those of said ports that were programmed responsive to said protection
5 switch to return them to their state prior to the protection switch.
- 1 51. The method of claim 50, wherein the state prior to the protection switch
2 includes a connection configuration programmed on the protecting channels of a first of
3 said spans that does not mirror a connection configuration programmed on the working
4 channels of said first span.
- 1 52. The method of claim 46, wherein said ring network is a BLSR ring.
- 1 53. The method of claim 46, wherein the same connection configuration must be
2 programmed on each of said sets of working channels.
- 1 54. The method of claim 46, wherein the same connection configurations must be
2 programmed on the set of working channels of both sub-spans of any given one of said
3 spans, and wherein the connection configurations programmed on the sets of working
4 channels of two different ones of said spans differ.
- 1 55. The method of claim 46, wherein the connection configurations programmed on
2 the sets of working channels of two different ones of said spans differ, and wherein the
3 connection configurations programmed on the set of working channels of each of the
4 sub-spans of at least one of said spans differ.
- 1 56. The method of claim 46, wherein the same connection configuration must be
2 programmed on the set of working channels of both sub-spans of any given one of said
3 spans.
- 1 57. A machine-readable medium providing instructions that, when executed by a set
2 of one or more processors, cause said set of processor to perform operations
3 comprising:

4 receiving, at a node of a ring network, a first message indicating a protection
5 switch, wherein said ring network operates on a plurality of network
6 elements that participate as nodes of said ring network and that are
7 connected by a plurality of spans to form a ring, each span including two
8 sub-spans on which traffic travels in opposite directions on a plurality of
9 channels, said plurality of channels in each direction including a set of
10 working channels and a set of protecting channels; and
11 responsive to said first message, reprogramming a receiving side of a first port
12 of said node coupled to one of said sub-spans so that its protecting
13 channels have programmed thereon the connection configuration of the
14 working channels programmed on the opposite direction sub-span of a
15 span identified by said first message.

1 58. The machine-readable medium of claim 57, wherein said operations further
2 comprise:
3 selecting from a storage of the connection configurations of the working
4 channels of each of said plurality of spans the connection configuration
5 used for said reprogramming.

1 59. The machine-readable medium of claim 57, wherein said operations further
2 comprise:
3 storing, prior to said receiving, the connection configurations of the working
4 channels of each of the spans not directly connected to said node.

1 60. The machine-readable medium of claim 59, wherein said operations further
2 comprise:
3 receiving, prior to said storing, from said plurality of network elements said
4 connection configurations.

1 61. The machine-readable medium of claim 57, wherein said operations further
2 comprise:
3 receiving, at said node, a second message indicating a protection un-switch; and
4 responsive to said second message, reprogramming said receiving side of said
5 first port to its state prior to the protection switch.

1 62. The machine-readable medium of claim 57, wherein said reprogramming also
2 includes reprogramming a receiving side of a second port of said node coupled to the
3 other direction sub-span of the ring relative to said first port, so that the protecting
4 channels on that sub-span have programmed thereon the connection configuration of
5 the working channels programmed on the opposite direction sub-span of the span
6 identified by said first message.

1 63. The method of claim 57, wherein said ring network is a BLSR ring.

1 64. A machine-readable medium providing instructions that, when executed by a set
2 of one or more processors, cause said set of processor to perform operations
3 comprising:

4 in a node of a ring network, storing a connection configuration programmed on
5 working channels on each span of said ring network not directly
6 connected to said node, wherein said ring network operates on a
7 plurality of network elements that participate as nodes of said ring
8 network and that are connected by spans to form a ring, each span
9 including two sub-spans on which traffic travels in opposite directions
10 on a plurality of channels, said plurality of channels in each direction
11 including working channels and protecting channels; and
12 responsive to a protection switch, reprogramming those ports of the node
13 coupled to the sub-spans delivering traffic to that node so that their
14 protecting channels have programmed thereon the connection
15 configuration of the working channels programmed on the opposite
16 direction sub-spans of a span that failed.

1 65. The machine-readable medium of claim 64, wherein said operations further
2 comprise:

3 receiving, prior to said storing, from said plurality of network elements said
4 connection configurations.

1 66. The machine-readable medium of claim 64, wherein said operations further
2 comprise:

3 responsive to a protection un-switch, reprogramming those ports of the node
4 coupled to the sub-spans delivering traffic to that node so that their

5 protecting channels have programmed thereon their state prior to the
6 protection switch.

1 67. The machine-readable medium of claim 66, wherein said reprogramming
2 responsive to said protection un-switch includes reprogramming the protecting
3 channels on a receiving side of two ports of the node with different connection
4 configurations.

1 68. The machine-readable medium of claim 64, wherein said reprogramming
2 includes reprogramming the protecting channels on a receiving side of two ports of the
3 node with different connection configurations.

1 69. The method of claim 64, wherein said ring network is a BLSR ring.

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